PART 12

PARTICULAR ELECTRICAL PLANT REQUIREMENTS

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PART 12

PARTICULAR ELECTRICAL PLANT REQUIREMENTS

12.1 Introduction

The specific design and performance requirements for all electrical equipment are given in this part of the Specifications. The Requirement specified shall be fully met with by the Contractor. In case of any deviations, the Contractor shall bring out the same in "Schedule of Deviations from Particular Requirement" failing which shall be considered that the Contractor fully complies with these requirements. General Requirement of electrical equipment is covered under Part-6 of this specification.

12.2 Scope of works

The scope of works for 10MLD Capacity TTP at Yelahanka, includes design, manufacture, testing at works, supply and delivery at site, unloading and storing the equipment at site of installation, installation, testing and commissioning of the following equipment at site

11kV Metal enclosed Switchboards, 11kV/0.433kV transformers with RTCC and OLTC panel, 415V Diesel Generator Sets with Acoustic Enclosure & AMF Panel, synchronising panel,MLDB,415V Metal enclosed switchboards / distribution boards / motor control centres, 415V capacitor banks with APFCR panel, Battery, Battery charger, DC Distribution board, Variable Frequency drives, Lighting system, Power & control cables, Cable carrier system, Earthing & Lightning protection system.

All equipment / items shall be of makes as specified in the list of preferred makes. Various equipment/ items shall conform to latest applicable standards specified. In case of Conflict between standards and this specification, this specification shall govern.

12.3 Primary Power Source

Electrical power supply for 10MLD Capacity TTP at Yelahanka shall be tapped from the existing incoming supply. There shall be enhancement of the power supply at 10MLD Yelahanka TTP. BESCOM shall make necessary arrangement to provide supply at any one point of plant premises.

Necessary double pole structure, lightning arrestors, 11kV Isolators, CTs, PTs, interconnecting cable from double pole structure to metering unit, metering unit and VCB shall be provided by BESCOM. This work shall be executed by BESCOM and amount needs to be paid to BESCOM through provisional sum for executing the above works.

The Contractor's scope includes liasoning with BESCOM for getting construction of enhanced power supply, making new/enhanced power supply agreement for the plant and getting final clearance from CEIG for complete Electrical system.

The Contractor's scope for TTP starts from the outgoing of corresponding 11kV VCB provided by BESCOM near two pole structure and shall cover all equipment / items as given above in clause 12.2, Scope of works.

12.4 Power supply arrangement

The Incoming 11kV (overhead line / underground cable) supply from BESCOM shall be terminated at outdoor two pole structure. Outgoing terminals of the two pole structure shall be connected further to outdoor 11kV metering unit to be located near two pole structure. The outgoing cable from the metering

unit shall be connected to incomer of 11kV Metal Enclosed Switchboard at TTP. The outgoings of the 11kV Metal Enclosed Switchboard shall feed two numbers 11/0.433kV Distribution Transformers. The two numbers 11/0.433kV Distribution Transformers shall feed total working load of TTP.

12.5 General Design Criteria for TTP/RSPS

All electrical equipment shall be rated for 45°C design ambient temperature. The installation shall generally conform to Indian Standards / IEC.

The following factors shall be considered for proper selection of electrical apparatus or equipment for areas where flammable gas or vapours may rise.

(a) Area classification

The classification of area shall be as per IS 5571 & IS 5572, based on the degree of probability with which explosive concentrations of combustible gas or vapour may arise in installations in terms of both the frequency of occurrence and probable duration of existence on each occasion.

(i) Zone 0 – In which an explosive gas/air mixture is continuously present or present for long periods.

(ii) Zone 1 – In which an explosive gas/air mixture is likely to occur in normal operation.

(iii) Zone 2 – In which an explosive gas/air mixture is not likely to occur in normal operation and if it occurs, it shall exist only for short periods.

(b) Gas Group Classification

The characteristics of the gas or vapour involved in relation to Igniting current or minimum ignition energy in case of installations of intrinsically safe apparatus or maximum experimental safe gap data in case of installations for flame proof enclosures as per IS 2148.

(c) Temperature Classification

The Ignition temperature of the gas or vapour involved, or the lowest value of ignition temperature if more than one combustible material shall be present.

The maximum temperature of any unprotected surface of electrical equipment shall not exceed the Ignition temperature of gas or vapour. For electrical apparatus, no margin of safety need be applied between maximum surface temperature and ignition temperature. The Ignition temperature of combustible gases and vapours are measured in accordance with the test method prescribed in IS 7820.

(d) **Environmental conditions** in which the apparatus shall be installed. Apparatus and its component parts shall be constructed so as to guard against electrical and mechanical failures in the intended conditions of use.

The selection of type of protection of electrical equipment for the different zones of Hazardous areas shall be made in accordance to Clause 6, Table -1 of IS 5571.

All electrical equipment installed in hazardous areas shall confirm to selection of equipment and installation guidelines of IS 5571.

12.6 HV System

a)	Nominal voltage	:	11kV
b)	Number of phases	:	3
c)	Frequency	:	50 Hz

d) Connection : 3 Wire
e) Maximum Fault Level/current : 500 MVA (26.25kA)

12.7 LV System

(a) General Supply

a) Voltage: : 415 V nominal
b) Frequency: : 50 Hz
c) Connection : 4 wire
d) No load transformer voltage : 433 V
e) System earthing : Solidly earthed
f) Maximum fault level/current : 36 MVA (50kA)
g) Fault Current : 50kA

All Plant shall, unless otherwise specified, be capable of continuous operation at a voltage level in the range of 90% to 110% of the relevant nominal voltage and a frequency variation of ±5% with a maximum combined tolerance of 10%.

(b) AC Control, Lighting and Space Heating

- Voltage: 240 V
- Phases: 1
- Frequency 50 Hz
- Connection 2 wire (Phase & Neutral)

(c) DC Control, Protection and Alarm

- Voltage: 110 V
- Phases: 1
- Connection 2 wire (unearthed)

12.8 HV Metal Enclosed Switchboard

12.8.1 11kV Indoor Switchboard

11kV Switchboard shall be indoor, floor standing, sheet metal enclosed with IP4X degree of protection, with draw out type vacuum circuit breakers for incoming & outgoing feeders, control & protection. The switchboard shall be rated for a fault current not less than 26.25 kA (rms). All protective relays shall be numerical type.

12.9 Distribution Transformer

12.9.1 11/0.433kV Transformers

The transformers shall be out door type, ONAN, 11/0.433 kV, 3 phase, 50 Hz, two winding, Dyn11 with solidly earthed neutral with OLTC.

The transformers shall be sized considering 20% contingency of total working load while arriving at the final capacity of transformers. Two numbers of transformers shall be provided such that under normal condition, each transformer shall be loaded up to 50% and in case of failure of any one transformer, the healthy transformer shall have capacity to take entire load so as to have 100% standby.

The transformers shall be designed such that at any point of time maximum loading (including Contingency Capacity) on any single transformer shall not exceed 80% of full load capacity.

12.9.2 ENERGY EFFICIENT INDUCTION MOTORS

(a) Motors shall be suitable for

1	Motors rated upto 355 kW	LT Supply
2	Motors > 355 kW	HT supply
3	Process Air Blower Motors upto 355 kW	HT or LT supply

(b) The Motors will be of Reputed and Reliable make and the same will be subject to approval of client's representative

(c) The Degree of Protection of Terminal Boxes of all Outdoor Motors shall be IP55.

(d) All the stator winding terminals of the induction motors shall be brought out up to the terminal box.

(e) All LT motors are required to be TEFC type with class 'F' insulation. Outdoor type Motor shall be with IP55 degree of protection and indoor shall be IP54. LT energy efficient motors shall be as per IS 12615 & IEEMA 19-2000 and shall have Efficiency Class equal to IE-2 as per IS 12615:2011.

12.10 System Protection

Numerical relay-based protection system for various parts of the power supply system shall be proposed. The following protection systems shall be used:

(a) 11 kV Incomer Feeder

- Instantaneous phase over current protection
- Instantaneous earth fault protection
- Inverse definite minimum time phase over current protection
- Inverse definite minimum time earth fault protection
- Potential transformer fuse failure protection
- Under voltage protection
- Negative phase sequence protection
- Breaker failure protection
- Inrush protection

(b) 11 kV Transformer Feeder

- Inverse definite minimum time phase over current protection
- Inverse definite minimum time earth fault protection
- Instantaneous phase over current protection
- Instantaneous earth fault protection
- Standby earth fault Protection
- Thermal overload protection
- Inrush protection
- Breaker failure protection
- Winding temperature high, alarm & trip
- Oil temperature high, alarm &trip
- Buchholz relay alarm and trip
- Magnetic oil level gauge alarm
- Restricted Earth Fault relay to be provided for Transformer rating 2MVA and above
- Pressure relief valve alarm & trip

- Oil surge relay trip
- Alarm annunciation with connectivity (communication port RS485) to PLC

(c) 415V Incomer Feeder

- Overload, Earth fault and short circuit protection
- Under voltage Protection

(d) LV Motors

(i) Motors less than 15kW

- Motor Protection relay with following protection
- overload protection by three phase thermal (bimetal) relay
- Single phasing preventer
- Motor Protection Circuit Breaker (MPCB)

(ii) Motors 15kW up to 75kW

- Electronic motor protection relay providing the following protection
- Overload
- Earth fault
- phase currents out of balance
- Single phasing preventer
- MCCB

(iii) Motors above 75kW

- Comprehensive motor protection relay providing the following protection
- Thermal Overload
- locked rotor
- Phase Over current (50/51)
- Earth fault (50N/51N)
- Over voltage & under voltage
- phase loss/reversal
- Negative sequence
- Protection for repeated and prolonged starts
- restart inhibition
- Single phasing preventer
- Temperature Monitoring (Alarm & Trip)
- ACB/MCCB

Note: - RTD's of Winding and Bearing Temperatures of Pumps / Motors shall be monitored through Temperature Scanner Indicators.

(iv) Pump Drives

All pumps shall be provided with the following additional protection, as per requirement:

- Dry run protection
- Temperature protection, (Submersible pumps)
- Moisture entry protection. (Submersible pumps)
- Over pressure (positive displacement pumps)

(v) Blowers

Blowers shall be provided with the following additional protection:

- Over pressure

(vi) Rotating Arm Drives

Rotating arm drives shall be provided with the following additional protection:

- motion detectors
- Over torque detectors

(vii) Valve Actuator Drives

Valve actuator drives shall be provided with the following additional protection:

- Over torque detectors

12.11 Switchgear Equipment / Instruments

(a) 11kV Feeders (Incomer and Transformer feeders)

- Ammeter for all 3 phases
- Voltmeter with selector switch
- KW meter
- KWh meter
- KVARh meter
- Frequency meter
- Power factor meter.
- Digital Multifunction meter with RS 485 connectivity for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

(b) 415V Incomer Feeders

- Ammeter with selector switch
- Voltmeter with selector switch
- KW meter
- Digital Multifunction meter with RS 485 connectivity for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

(c) 415V Motor Starter Feeders

- Ammeter with selector switch
- Voltmeter with selector switch
- KW meters for Motor feeders more than 75kW
- Multifunction meters with facility to extract historical data for Process Air Blower Feeders and for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters
- DOL Starters for motor feeders less than or equal to 5.5kW
- Star-Delta Starters for motor feeders above 5.5kW and up to 75kW
- Soft Starters for motor feeders above 75kW

12.12 Standby Diesel Generator Sets

There shall be Standby Diesel Generator Set with Acoustic Enclosure and AMF panel at TTP location. The capacity and number of Standby Generator(s) shall be sized for power back up for all critical loads/Working Loads which are required for continuous operation of the corresponding TTP plant during main power failure. Working loads of the entire Plant and 15% Contingency over these loads shall be considered while sizing the DG Set. One number of DG set with AMF panel on suitable rating shall be provided as back-up power source for 10MLD Capacity TTP at Yelahanka.

Automatic Main Failure Panel

One AMF (Automatic Main Failure Panel) panel shall be provided for the Diesel Generator Set.

In case of main failure detected by an under-voltage relay mounted in the AMF panel, the main breakers (receiving the main power from BESCOM) shall be switched off under auto mode. Consequently, the standby generator starts in the auto mode. After the generator set reaching the rated speed and rated voltage, the generator circuit breakers shall be switched on to feed Diesel Generator power to the AMF panel. On restored main supply, the reverse sequence of the above shall be followed for the mains supply to feed power to the loads as in normal condition.

The two breakers in the panel shall be operated manually at the AMF panel during trouble shooting or maintenance.

12.13 415V PCC / MCC

415V PCC/MCC shall be floor standing, sheet steel enclosed with IP 54 Degree of Protection, Form–IV enclosure as per IS 8623 complete with Air circuit breakers/MCCB's /MPCBs, Control & Protection. The PCC / MCC shall be rated for a fault current not less than 50kA (rms) for 1 sec.

All Motor Feeders in the MCC Panels shall have Contactors, Start-Stop Pushbuttons, ON-OFF-Trip indication and OLR reset button. All starter feeder shall have with Type-2 coordination and Contactors have AC3 duty.

All Motor Feeders in the MCC Panels shall be operated from PLC. Emergency stop push button will be provided near the motors. All the door locks shall be provided with special keys to ensure opening by authorized personal only. Earth bus-bar shall be extended outside the switchboard at the ends

Panel height shall not be more than 2300 mm (Including 100mm base ISMC if it is pedestal mounted). The depth of panel shall not exceed 1350mm & any operating handle of switchgear shall not be more than 1800 mm and not lower than 300 mm from base of the panel. Substation/MCC/Switchgear/ Electrical building shall have at least 3 metres clear room height.

The exposed bus live parts in the cable alley shall be totally covered against accidental contact by a shroud (and not by sleeve) to protect the workmen working on the switchgear.

12.13.1 Local Control Panel (LCP)

For each motor:

- Local / Off / Remote selector switch to be provided. 3 Push buttons "START / STOP / EMERGENCY STOP" shall be provided.
- Start push button operates only when the switch on LCP is in "Local" position.
- Stop push button shall operate only after pre-determined requirement of closing the delivery valve either in Local mode or Remote mode for 90kW and above pump motors.
- Emergency Stop push button operates irrespective of the position of the selector switch.

When the selector switch on LCP is in "LOCAL" position, the motor shall be operated by push buttons on LCP and shall take into account only the specific fail-safe controls of the equipment

(electrical protections, low level for a pump). When the selector switch on LCP is in "REMOTE" position the drive shall be operated from PLC

Motorized valves shall be with fully integrated control Actuator. The actuator comes with integrated:

- One Selector switch "Remote / Local"
- Control switch for: OPEN / CLOSE / STOP.
- Local Control cubicle with remote operation from PLC with position feedback.

12.13.2 Operation Logic of Switchgears

Operation Logic of 415V Metal Enclosed Switchboard at TTP Substation:

- At normal condition, both the Incomers shall be in Closed Position and the DG Incomer & Buscoupler shall be in Open Position.
- If any Incomer fails the faulty Incomer shall be in Open Position, the Buscoupler and the healthy Incomer shall be in Closed Position.
- In Case of Power Failure, DG Incomer & Buscoupler shall be in Closed Position and the Mains Incomer shall be in Open Position. The critical loads of the plant shall run on DG Set.

12.13.3 Capacitor Banks and Power Factor Correction

The LT capacitor banks provided shall be of bus connected type with Automatic Power factor correction, the system shall be designed such that a power factor of not less than 0.98 shall be maintained.

Automatically controlled multistage power factor correction shall be provided. 2 Nos. PFC panels providing not less than adequate numbers (as per market availability) PFC stages per panel shall be provided each connected to one bus section of the LT Switchboard. The PF on each bus section of the board shall be monitored and corresponding PFC capacitors switched in and out automatically in discrete stages to maintain a set point PF value.

Each panel shall be configured such that no PFC capacitor stages shall operate when the standby generator is powering the side of the distribution board to which shall be connected. Reactors shall be provided for the protection of capacitors.

MCCBs, Switches, Contactors shall be suitable for making and braking current of the capacitors. The Panels shall be floor standing, sheet steel enclosed with relevant degree of Protection.

12.13.4 Variable Frequency Drives

VFD shall be considered as per process requirement. Minimum loads shall be provided with Variable frequency Drives with communication port:

- Raw Sewage pumps (RSPS location)
- Process Air Blowers
- Return Activated Sludge Pumps
- Alum Dosing Pumps
- Polymer Dosing Pumps

12.13.5 DC Power Supply

DC Power supply shall be provided for protection and control in 11kVSwitchgears

Local circuit breaker shall be provided for batteries.

A Conventional system operating at 110V DC using maintenance free rechargeable Ni-Cd batteries shall be provided and shall be complete with battery, redundant battery charger with boost & trickle charging facilities, necessary controls, indications and DC distribution board.

The battery room shall be provided with acid proof tile flooring, corrosion proof lighting fixtures, exhaust fans and wash basin.

12.14 Cabling

(a) 11kV Power Cables

The cables shall be 3 core, 11kV (UE), XLPE type with stranded aluminium conductors & GI armouring. Minimum size of cable shall be selected based on the short circuit current considerations.

(b) LV Power Cables

LV power cables shall be 1.1kV XLPE type with stranded Aluminium/Copper Conductors with GI armouring for the following sizes:

(i) ≤ 6 Sq.mm. - Stranded Copper conductors with GI armouring cable

(ii) > 6 Sq.mm - Stranded Aluminium conductors with GI armouring cable

No. of cores shall be as per requirement.

(c) Control Cables

Control cables shall be 650/1100V, XLPE with stranded copper conductors and GI armouring. No. of cores shall be as per requirement. Minimum size of core shall be 1.5 Sq.mm.

(d) Cable Rating

All power cables shall be sized for continuous current carrying capacity and permissible voltage drop at an ambient temperature of 45 degrees C. Due consideration shall be taken of cable grouping, method of installation and local variations in ambient conditions. Further, for cables controlled by circuit breakers, due consideration shall be given to the fault level.

HV and LV cables shall be sized for a minimum fault clearance time of 1 second for incoming feeders, 0.5 seconds for tie feeders and 0.5 second for equipment feeders

For all LT Cables, the voltage drop in the cables between the transformer and the switchgear (PCC/ PMCC) or between PCC/ PMCC and MCC for full load current shall be limited to 2%. Further the voltage drop in cables between PCC/MCC to Motor terminals for full load current shall be limited to 3%. The Total Voltage drop transformer secondary to motor terminal shall be limited to 5%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energisation.

(e) Cable Installations

Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. These shall be used to route cables along walls, below beams and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made while sizing the cables.

Cables of different categories shall be installed to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cables.

Table of Separation Distances between different Categories of Cable.

Cable Category	HV Power	LV Power	C&I/Protection	Telecomm
HV Power	N/A	300	500	500
LV Power	300	N/A	300	300
C&I/Protection	500	300	N/A	100
Telecomm	500	300	100	N/A

(f) Cable Numbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Cables of different categories shall be tagged with the following subscripts and a three-digit number.

- HV power HV-P_ _ _
- LV power P_ _ _
- Control C_ _ _
- Instrumentation I_ _ _
- Protection PR_ _ _
- Telecommunication T_ _ _

12.15 Building Services

(a) Lighting

All internal and external areas shall be provided with LED lighting. The illumination levels to be achieved shall be as follows:

Illumination System

Latest version of related IS standards, NBC and National Lighting Code (NLC) shall be referred for designing Illumination for different areas.

All lighting design shall be carried out on Dialux latest version or OEM specific software.

The basis of design shall be based on the following lighting engineering criteria, as per relevant standards or specified herewith:

a) Lighting lux level
b) Luminance distribution
c) Glare restriction
d) Direction of incidence of light and shadow effect
e) Colour appearance and colour rendering of the light source

f) Uniformity

Selection of Luminaries and Illumination Level: The following luminaries shall be provided for various areas in order to achieve the average luminance as per various relevant lighting standards or those indicated below:

Sl. No.	Area	Type of Light Fittings	Lux
1	Pump house	Surface Mounted LED batten	200 Lux
2	Battery room	Industrial type LED batten	150 Lux
3	Machinery service area	Industrial type LED batten	200 Lux
4	Offices and conference rooms	LED Surface mounted decorative down lighter fitting with polycarbonate cover	300 Lux
5	Switchgear room/MCC, DG room	Industrial type LED batten	200 Lux
6	Control rooms/ SCADA room	LED Surface mounted decorative down lighter fitting with polycarbonate cover	300 Lux
7	Chemical and general stores	Industrial type LED batten	150 Lux
8	Chemical plant room	Anti-corrosion Industrial LED batten	200 Lux
9	Cable basement	Industrial type LED batten	100 Lux
10	All other indoor areas	Industrial type LED batten	100 Lux
11	Outdoor platforms and walk ways	LED Bollard post tops and Uplighter	50 Lux
12	Building entrance	LED Surface mounted decorative down lighter fitting with polycarbonate cover	100 Lux
13	Outdoor plant areas	LED Flood lights	20 Lux
14	Outdoor transformer yards - General - On equipment	Industrial type LED batten	 20 Lux 30 Lux
15	Roads (secondary)	Industrial type LED batten	20 Lux

Ceiling fans shall be provided in offices, control rooms and they shall be connected to local lighting circuit.

The internal lighting installation shall be installed using single core, XLPE insulated copper cable enclosed in galvanized iron conduit. Lighting in external areas shall be installed using multicore armoured cable

Following factors shall be considered while arriving at the utilization factor to determine the number of fixtures for each area/building:

a) Maintenance Factor
- Indoor Area Lighting with LED Luminaire : 0.7
- Outdoor Area Lighting with LED Luminaire : 0.6

b) Reflection factor for Indoor Lighting to be considered are as follows:

- Ceiling : 0.5
- Walls : 0.3
- Floors : 0.1

c) However, Reflection factor can be selected based on the Color of the wall and Ceiling as given below:

- White and very light colors : 0.7
- Light colors : 0.5
- Middle tints : 0.3
- Dark colors : 0.1

d) Room index at applicable surface reflection factors need to be considered.
e) The working plane shall be considered at 0.75 m from the floor level.
f) Uniformity factor shall be considered as per National Lighting code/ NBC/ IS code.

The power supply for lighting shall be distributed from Lighting Distribution Boards and feeder pillars.

For street lighting, cabling shall be done with 4C armoured cable such that alternate fixtures are different phases.

Wiring:

(i) Wiring for lighting in office & pumping station internal areas will be done with 1.1Kv, PVC insulated, stranded copper conductor wires of area not less than 2.5 sq mm in concealed conduits.

(ii) ii) Lighting in external areas shall be installed using multicore armored cable

(b) Emergency Lighting

Self-contained chargeable type emergency luminaires shall be provided in all internal premises except Substation building and the Contractor shall maintain minimum illumination level of 5 lux. These luminaires shall automatically illuminate in the event of a power failure and provide a minimum level of lighting for approximately 3 hours. They shall automatically recharge on the return of mains power.

(c) Ventilation & Exhaust Fans (3 phase)

Variable speed ventilation ceiling fans & exhaust fans shall be provided in offices and switchgear rooms as per requirement. One Ceiling fan of 48" size shall be provided for each 10 m^2 or part thereof of the area concerned.

Where fitted ceiling fans shall be connected to the local lighting circuit.

(d) Small Power Outlets

Switched single phase three pin 5 A and 15A receptacles shall be provided throughout. In offices and control rooms they shall be modular decorative type and industrial type in all other areas for single and three phase sockets. All outlets for domestic pump, dewatering pump, submersible sump pump shall be provided with local starter panel or control cubicle. All metal clad sockets shall be provided with suitable metal clad plug.

Unless required to be provided in greater numbers to power specific Plant items the number of such outlets shall be as follows:

- 5 A type one outlet per 5 m or part thereof of perimeter in offices and laboratories
- 5 A type one outlet per 20 m or part thereof of perimeter in all other areas
- 15 A type one outlet per 20 m or part thereof of perimeter in offices and laboratories
- 15 A type one outlet per 20 m or part thereof of perimeter in all other areas.

(e) 3-Phase Power Outlets

32A switched (MCB) three phase and neutral receptacles shall be provided in plant areas where appropriate i.e. adjacent to areas where flooding is likely (to permit the use of portable sump pumps) or where other portable equipment is likely to be used in the operation of the treatment plant. The Contractor shall install ten such outlets at various locations throughout the treatment plant.

The location of outlets shall be approved by the Engineer. The spacing of 5A and 15A outlets shall be arranged to suit the intended location of equipment, desks etc.

Receptacles for outside areas shall have a degree of protection of IP 65.

12.16 System Earthing & Lightening Protection

An earthing system comprising earth electrodes and conductors shall be established for Sewage Treatment Plant.

The earthing system shall be designed to give a combined earth resistance value of not greater than 1 ohm. In order to be sure of obtaining suitable final values, soil resistivity shall be measured at the various sites during the detailed design phase of the work.

In outdoor substation areas the main earth electrode conductors shall be located, to ensure potential gradients occurring at the surface during fault conditions are kept within allowable limits.

Materials used for earth electrodes shall be designed to suit the ground conditions and shall be Galvanised steel.

The system shall be designed for the following maximum earth fault currents. These values shall be confirmed at the detailed design phase.

- **11kV system 26.25 kA.**
- **415V system 50 kA.**

The fault clearing time shall be taken as **one second** for the 11kV and 415V systems.

The maximum temperature allowed for steel welded joints shall be taken as 500 degrees C with an ambient of 45^{o} C. Main equipotential bonding conductors shall be galvanised steel.

Circuit protective conductors shall comprise either the armouring of the supply cable or, for major loads such as main switchboards and large drives the supply cabling plus an additional suitably sized single core copper cable.

All earthing pits shall be of treated pits only.

Transformer and DG Set neutral earthing shall be of copper earthing.

The neutral point of the 11/0.433 kV transformer secondary windings shall be solidly earthed.

Lighetning protection system shall be provided on all main structures. Air terminations and down conductors shall be GI.

The lightening protection system need shall be established by calculating the risk factor value of each building, structure etc as per procedure given in IS/IEC: 62305.

The lightening protection installation shall comply with Standard Specifications.

Air termination system comprising of rods/mesh or combination of both shall be provided and the methods used to determine the positioning of Air Termination system shall be as per IS/IEC 62305.

Air termination system shall be connected to the earthing system by down conductors fixed along the outer surface of building. Number & layout of the down conductors shall be as per IS/IEC 62305.

Each down comer shall be terminated to a separate treated test earth electrode which in turn will be connected to the station earthing system.

Test link shall be provided in the run of each down conductor at approximately 1000 mm above ground level.

FIRE ALARM & PROTECTION SYSTEM

Fire alarm system shall be provided for electrical buildings and control room

Fire Alarm system shall be designed to provide continuous surveillance against fire in the areas covered by the system under all conditions.

Fire alarm system shall be capable of notification of fire alarm, supervisory and trouble condition and to control fire safety functions. The design requirements are defined as part of design engineering, fire alarm scheme based on requirements of NFPA 72, National Fire Alarm Code (2002 edition).

The Fire alarm control panel, detectors and other related devices used in the system shall conform to international Standards UL/ LPCB/ FM.

The following annunciation but not to limited to these shall be available in the control room

Fire on the transformer

Fire/fault in particular Zone

Manual call point of outdoor type shall be provided on each gate of switchyard and inside the switchyard shall be such that no person inside the switchyard has to travel more than 30m to 40m to raise the alarm.

Fire fighting system shall contain but not to limited to, the items listed below –

Portable fire extinguishers

Nitrogen injection fire prevention method for transformer Sand & Water Bucket.

12.17 Qualification Criteria for Electrical agency/vendor for Design, Supply, Program, Execution and Commissioning of Electrical Works

The contractor shall submit the following documentation as part of credentials submissions for the electrical works for design, supply, and program, execute and commission the electrical works.

The agency which shall design, supply, program ,execute and commission electrical equipment system (HT & LT) on a minimum, shall be operating under an accredited ISO 9001:2015 system and shall be a Class-A electrical contractor with state PWD or central PWD, with a minimum of 10 years' experience of having designed, executed & completed complete electrical systems for TTP's, inclusive of supply, installation and commissioning; on a single facility within India during the last five years and shall demonstrate capability and resources for integrating/interfacing with control systems from different manufacturers as well as coordination with multiple agencies for contract execution.

The agency shall demonstrate in house FAT facility with FAT simulation panel and other required hardware and software to conduct FAT as required under this contract. Agency shall submit documentation to validate the same as part of credentials submission.

The Agency on a minimum, shall have executed & completed at least ten individual STP/TTP contracts of minimum 8 MLD capacity for electrical system as required under this contract within India, during the last ten years period. Verification end user performance certificates shall be submitted for the same.
Note: In the event, if the OEM intends to execute (design, supply, program, execute and commission) the works, the OEM shall comply in full to the qualification criteria as required in this clause & specification.

The agency shall have an Electrical manager with minimum fifteen years of relevant experience and at least two team leaders with minimum seven years of relevant experience. The agency shall have minimum five number of design engineers with at least three years of relevant experience in design, installation and Commissioning of works similar to this contract and overall capacity and process. The engineers shall be on its permanent employment. Proof of ESIC/PF should be submitted to demonstrate the permanent employment. (Associate Employer Representatives/ Advisers/ consultants shall not be considered). The agency shall submit documentation and signed resumes of the personnel as part of credentials submission. The contractor and agency shall depute only approved personnel, who's resume has been approved.

12.18 HT Metal Enclosed Switchboard

Sr. No.	Description	Unit	Technical Particulars
12.19.1	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
12.19.2	Type		As per Specification

Sr. No.	Description		Unit	Technical Particulars
12.19.3	Applicable Standards			As per Specification
12.19.4	Quantity		No.	(*)
12.19.5	**Switchgear cubicles and Bus bar ratings**			
(a)	Rated voltage, phases and frequency			11kV, 3 phase, 50 Hz
(b)	System Neutral Earthing			Resistance earthed
(c)	Maximum system voltage		kV	12
(d)	One-minute power frequency withstand voltage		kV (rms)	28
(e)	12/50 μsec impulse withstand voltage		kV (peak)	75
(f)	Short circuit withstand			
	(i) Short time (1 sec) at rated voltage		kA (rms)	26.25
	(ii) Dynamic rating		kA(peak)	65
(g)	Reference ambient temperature			45°C
(h)	Maximum temperature of bus bars droppers' connectors and contacts at continuous current rating under site reference ambient temperature			Joints, Silver faced : 100°C Busbars and other joints : 85° C
(i)	Continuous current rating of bus bar		A	(*)
(j)	Bus bar material			Copper
(k)	Bus bar Insulation			Fully insulated by encapsulation in epoxy resin with mould caps protecting all joints
(l)	Cable entry			Bottom
(m)	Cable type for Incoming and Outgoing feeders			11kV (UE), XLPE Aluminium conductor with GI armouring
12.19.6	**Switchgear constructional Requirement**			
(a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partitions		mm	Frame – 2.5min, Doors/Covers/partitions – 2.0min
(b)	Degree of protection			IP4X for panel enclosure & IP52 for metering compartment.
(c)	Colour finish shade			Interior - Glossy white
				Exterior - Light grey semi-glossy shade 631 of IS:5
(d)	Earthing bus	i) Material		Copper (run throughout the panel)
		ii) Size	mm x mm	(*)

Sr. No.	Description		Unit	Technical Particulars
(e)	Earthing conductor	i) Material		GS Flat
		ii) Size	mm x mm	(*)
12.19.7	**Breaker Particulars**			
(a)	Circuit breaker type			3 pole, Vacuum draw out type, truck mounted with Surge Suppressor, trip free mechanism & anti pumping feature
(b)	Voltage, phases and frequency			12 kV, 50 Hz, 3 Ph
(c)	Rated operating duty			O –0.3 sec. – CO – 3 min - CO
(d)	Rated current at reference ambient temperature (i) Incoming breakers		A	(*)
	(ii) Outgoing breakers		A	(*)
(e)	Rated breaking capacity		kA (rms)	26.25
(f)	Rated making current		kA (peak)	65
(g)	Short time current withstand for 1 sec duration		kA (rms)	26.25
(h)	Total break time			Less than 50ms
(i)	Operating mechanism type (Normal)			Motor spring Charged stored energy type for closing and tripping
	Operating mechanism type (Emergency)			Manual Spring Charged for closing and tripping
(j)	Minimum no. of auxiliary contacts			6 NO+ 6 NC
(k)	Withstand test voltage			
	(i) One-minute power frequency		kV (rms)	28 75
	(ii) 1.2/50 μ sec impulse		kV (peak)	
(l)	Auxiliary control voltage (i) For closing / tripping coil			110 V DC
	(ii) For spring charging motor			240 V AC
	(iii) For space heaters and lighting			240 V AC
	(iv) Permissible variation in operating voltage of closing & tripping coils			85 to 110% for closing coil 70 to 110% for tripping coil
(m)	Anti-pumping feature			To be provided

Sr. No.	Description	Unit	Technical Particulars
(n)	Latching requirement		Trip free
12.19.8	**Current Transformers**		
(a)	Type		Cast resin window type
(b)	Class of insulation		Class E or better
(c)	Rated current ratio and burden (i) Incomers and bus couplers		 (*)
	(ii) Outgoing feeders		(*)
(d)	Accuracy class (i) Metering		 1.0
	(ii) Protection		5P20 and PS for core connected to Restricted Earth fault relay
(e)	Short time 1 sec current rating	kA (rms)	26.25
(f)	Dynamic rating	kA (peak)	65
12.19.9	**Voltage Transformers**		
(a)	Type		Cast resin
(b)	Rated Voltage (i) Primary	 V	 11000/√3
	(ii) Secondary – S1	V	110/√3, 110/√3
(c)	Method of connection (i) Primary – P		 Star, earthed
	(ii) Secondary – S1		Star, earthed
(d)	Application – S1		Metering and protection
(e)	Rated burden	VA	(*)
(f)	Accuracy class		Metering 1.0
			Protection 3P
(g)	Rated voltage factor (i) Continuous		 1.1
	(ii) Short time		1.5
(h)	Insulation class		Class E or better
12.19.10 (a)	**Meters** Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Accuracy Class		
	(i) Indicating Meters		Class 1.0
	(ii) Energy Meter		Class 1.0
12.19.11	**Protective Relays**		
	Type		Numerical Type
	Auxiliary supply		110V DC
12.19.12	**Annunciations**		
12.19.12.1	**Annunciations for Metal enclosed Switch board**		
(a)	Following alarm annunciation shall be provided on the 11kV Metal Enclosed		

Sr. No.	Description	Unit	Technical Particulars
	Switchboard Incoming feeders (i) Tripped on fault (ii) O/C&E/F operated (iii) Trip circuit supervision unhealthy (iv) DC fail (v) AC fail		
(b)	For each Outgoing transformer feeder circuit breakers (i) Tripped on fault (ii) O/C&E/F operated (iii) Buchholz, WTI, OTI trip (iv) Trip circuit supervision unhealthy (vi) DC fail (v) AC fail (vi) Buchholz, WTI, OTI, Oil level low alarms		
(c)	For Other Outgoing feeders (i) Tripped on fault (ii) O/C&E/F operated (iii) Trip circuit supervision unhealthy (iv) DC fail (v) AC fail		
(d)	For Bus PT (i) Under voltage trip (ii) DC fail (iii) AC fail		
(e)	Spare windows : 2 Nos. Min.		
12.19.13	**Cubicle Components**		
	Each 11kV circuit breaker cubicle shall be provided with the following minimum standard accessories		
(a)	One control switch 'trip-neutral-close' spring return to neutral position		
(b)	One control selector switch 'Local-Off-Remote stay-put' type		
(c)	LED Indicating lamps (i) 'Red' for breaker in 'On' indication (ii) 'Green' for breaker 'Off' position (iii) 'Amber' for breaker tripped on fault 'White' for trip circuit healthy (iv)'Red' for breaker in 'Service' position (v) 'Clear' for breaker in 'Test' position (vi) 'Blue' for breaker spring 'Charged' (vii) 'Amber' for DC fail (viii) 'Amber' for AC fail (ix) 'Red', 'Yellow', 'Blue' for supply healthy for incomers. (x) 'Ready to close'		

Sr. No.	Description	Unit	Technical Particulars
(d)	Mechanical trip push button to trip the breaker when control supply is lost. The push button shall be shrouded type		
(e)	One electrical anti-pumping relay		
(f)	Double pole control supply MCB one each for AC & DC control supply Cubicle space heater of adequate capacity with thermostat		
(g)	240V, 1 Phase, 50Hz, 15/5A, 5 pin receptacle with switch		
(h)	Cubicle lamp with door interlock switch		
12.19.14	**Auxiliary A.C. Supply**		
	240V, 1Ph, 50Hz supply shall be made available to each cubicle of 11kV Metal Enclosed Switchboards separately for provision of following by providing control transformer		
(a)	Spring charging motor		
(b)	Cubicle space heater with thermostat		
(c)	Cubicle lamp		
(d)	240V, 1Ph, 50Hz 15/5A 5 pin receptacle with switch		

12.19 Distribution Transformers

Sr. No.	Description	Unit	Technical Particulars
12.20.1	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
12.20.2	Type		As per Specification
12.20.3	Applicable Standards		As per Specification & IS 1180
12.20.4	Rated output	KVA	(*)
12.20.5	Quantity required	Nos.	Redundant
12.20.6	Transformer location		Outdoor
12.20.7	No load transformer ratio	kV/kV	11/0.433kV
12.20.8	Number of phases		3
12.20.9	Rated frequency	Hz	50
12.20.10	Impedance at all taps Standard losses	% Watts	Value as per IS 1180. As per IS 1180 under revised BEE Energy efficiency level category(Amendment no 4, march, 202 1)
12.20.11	Number of winding / materials of conductor / Insulation class		Two/Copper/class-A
12.20.12 (a)	Method of connection HV winding		 Delta

Sr. No.	Description	Unit	Technical Particulars	
(b)	LV winding		Star	
12.20.13	Vector group		Dyn11	
12.20.14	LV Neutral		Solidly earthed	
12.20.15	Type of cooling		ONAN	
12.20.16	Tap changer		Full capacity, microprocessor base On-load type on HV side with local marshalling box and Remote Tap Changing panel	
12.20.17	Tap range	%	+ 5 % to -15 %	
12.20.18	Tap step	%	2.5 %	
12.20.19 (a) (b)	Terminal connection HV terminals LV terminals		 Cable box suitable to 11kV UE, XLPE, Al. Conductor, armoured cable of size (*) Cable box suitable for 1100V XLPE, Al. Conductor armoured cables (*) For transformer ratings greater than 1000kVA should be suitable for termination of Non-Segregated Aluminium Bus duct (*)	
12.20.20 (a) (b)	Current Transformer On LV On LV Neutral		 (*)	
12.20.21	LV Neutral earthing		LV Neutral shall be brought out through a 1.1kV rated bushing, both inside the cable box for forming the 3Ph, 4-wire system and outside the cable box for direct connections to earth	
12.20.22	Insulation of Windings		H.V.	L.V.
(a)	One-minute power frequency withstand voltage (dry and wet)	kV (r.m.s)	28	3.0
(b)	1.2/50 micro second full wave impulse withstand voltage	kV (peak)	75	-
12.20.23	Insulation of bushings		H.V.	L.V. (Line and Neutral)
(a)	Rated Voltage of bushing	kV	17.5	1.1
(b)	One-minute power frequency withstand voltage	kV (r.m.s)	38	3.0
(c)	1.2/50 microsecond full wave impulse withstand voltage	kV (peak)	95	-

Sr. No.	Description	Unit	Technical Particulars	
(d)	Minimum creepage distance	mm	25mm/kV on 17.5kV	25mm/kV on 3kV
12.20.24	Vacuum withstand capability of transformer main tank with bushings, radiations, fitting and accessories.		250mm of mercury up to 200kVA, 500mm of mercury above 200kVA	
12.20.25	Inspection		As per IS 1180, Complete Routine test and one each from Type test and Special test to be indicated in QAP for witness	

12.20 415 V Metal Enclosed Switchgears (PCC) /PMCC/MCC

Sr. No	Description	Unit	Technical Particulars
12.21.1	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
12.21.2	Type		As per Specification
12.21.3	Applicable Standards		As per Specification
12.21.4	Quantity	No.	(*)
12.21.5	**415 V Switchgear and Busbar Ratings**		
(a)	Rated voltage phase and frequency		415V, 3 Ph, 50 Hz
(b)	System Neutral Earthing		Solidly earthed
(c)	Maximum system voltage	V	476
(d)	One-minute power frequency voltage		
	i) Power circuits	V	2500V (rms)
	ii) Control circuits	V	1500V (rms)
	iii) Aux. Circuits connected to Sec of CTs	V	1500V (rms)
(e)	Continuous current rating of Bus bars under site reference Ambient Temperature and type & material	Rating Material	(*) Copper
(f)	Bus bar insulation		Fully insulated encapsulation in epoxy resin with moulded caps protecting all joints
(g)	Reference Ambient Temperature	^{o} C	45
(h)	Maximum Temperature of Bus bars, Droppers and Contacts at	^{o} C	85^{o} C for bus bars and non-silver-plated joints

Sr. No	Description		Unit	Technical Particulars
	Continuous current rating under site ambient temperature			100^{o} C for silver plated joints
(i)	Short Circuit current withstand for Bus bars and droppers (i) Short time 1 sec		kA (rms)	50
	(ii) Dynamic Rating		kA (peak)	125
12.21.6	**Switchgear Constructional Requirement**			
(a)	Type of Construction			Single front fixed type (Except for air Circuit Breakers, which shall be draw out type). Construction features shall be as per specification.
(b)	Thickness of sheet steel (i) Frame, Frame enclosures, doors, covers and partitions		mm	CRCA– 2.0
(c)	Degree of protection			IP 54 indoor and IP 65 for outdoor
(d)	Colour finish shade			Interior: Glossy white
				Exterior: Light grey semi glossy Shade 631 of IS-5
(e)	Earthing bus	Material		Copper (run throughout the panel)
		Size	mm x mm	(*)
(f)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(g)	Minimum clearances in air of live parts (i) Phase to Phase		mm	25.4
	(ii) Phase to Earth		mm	25.4
(h)	(i) Cable entry (ii) Cable entry for panels above wet well			Bottom Top
12.21.7	**Instrumentation Transformers**			
(a)	Current transformer			
	(i) Ratio			(*)
	(ii) Burden		VA	(*)
	(iii) Accuracy Class			1.0

Sr. No	Description	Unit	Technical Particulars
(b)	Voltage transformer		
	(i) Ratio		(415V/ √3) / (110V/ √3)
	(ii) Burden	VA	50
	(iii) Accuracy Class		1.0
(c)	Auxiliary A.C. Supply		240V, 1Ph, 50Hz supply shall be made available to each cubicle of 415V Metal Enclosed Switchboards separately by providing control transformer
12.21.8	**Starters**		
(a)	Contractor rated duty		AS PER IS:13947
(b)	Utilisation category		AS PER IS:13947
(c)	Control transformer		
(d)	Standard applicable		As per Specifications
(e)	Thermal over load relay reset		
12.21.9	**Circuit Breakers**		
(a)	Circuit breaker type		Air circuit Breaker
(b)	Voltage, frequency & no. Of phases		415V, 3 PHASE, 4W,50Hz
(c)	Rated breaking duty		B-0.3 SEC-MB-3 SEC-MB
(d)	Rated breaking capacity (i)MVA KA(RMS) at 415V 0.25 p.f.		
(e)	Short circuit withstand current for 1 sec. Duration	kA (RMS)	50
(f)	Rated making current	kA(PEAK)	125
(g)	Type Of Operating Mechanism		Motor wound spring charged
(h)	Minimum No Of Auxiliary Contacts		6 NO + 6 NC
(i)	Standards Applicable		As per specs
12.21.10	**MCCB's**		
(a)	Moulded case circuit breakers to be provided. (a) for motor control circuits (b) for other circuits		
(b)	Voltage, frequency & no of phases		415V, 50Hz, 3PH

Sr. No	Description	Unit	Technical Particulars
(c)	Rated operating duty		O-3MIN-CO-3MIN-CO
(d)	Rated breaking capacity (at 415v 0.25 p.f.)	kA(RMS)	50
(e)	Rated making current	kA (Peak)	125
(f)	Rated current at site reference ambient temperature		As per Specifications
(g)	On/off operation Manual Remote power operated		Yes Yes
(h)	Releases required Over load inverse time Under voltage		Yes Yes
(i)	Standards applicable		Standards applicable

12.21 Power Capacitor and Control Panel

Sr. No	Description	Unit	Technical Particulars
12.22.1	**General**		
(a)	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Type		As per Specification
(c)	Applicable Standards		As per Specification
(d)	Quantity	No.	(*)
(e)	Rated Capacity	KVAR	(*)
(f)	Rated supply voltage	V	415
(g)	Rated frequency and phases		50Hz, 3Phase
(h)	Reference Ambient temperature	^{o} C	45
(i)	Cable gland required		Yes
(j)	Type of cable		1.1kV, XLPE, Al. Conductor
(k)	Size of cable		(*)
(l)	Cable entry		Bottom
12.22.2	**Constructional Requirement**		
(a)	Thickness of sheet steel i) Frame, Frame enclosures, doors cover and partition	mm	CRCA 2.0
(b)	Degree of protection		IP 42

Sr. No	Description		Unit	Technical Particulars
(c)	Colour finish shade			Interior: Glossy white
				Exterior: Light Grey Semi Glossy Shade 631 of IS-5
(d)	Main bus bars and size			Copper and (*)
(e)	Maximum Temperature of Bus bars, Droppers and Contacts at Continuous current rating under site ambient temperature		^{o} C	85^{o} C for bus bars and non-silver-plated joints 100^{o} C for non-silver-plated joints
(f)	Earthing bus	Material		Copper (run throughout the panel)
		Size	mm x mm	(*)
(g)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
12.22.3	**Design Requirement**			
(a)	Insulation level		kV (rms)	3.0
(b)	Capacitor bank connection			Delta
(c)	Short circuit withstand for busbars i) Short time (1 sec)		kA (rms)	50
	ii) Dynamic		kA (peak)	125
(d)	Type of switching			Automatic switching responsive to power factor through power factor sensing relay
(e)	Switching steps			Minimum 8 steps
(f)	Switch and Rating of contactor			To suit KVAR of unit (switching duty)
(g)	Incomer MCCB current rating			To suit rated capacity of capacitor banks (switching duty)
(h)	O/L capacity of capacitors			30% of rated capacity as per IS
(i)	O/V capacity of capacitors			10% of rated voltage as per IS
(j)	Protections			O/V, U/V and O/L

12.22 Diesel Standby Generator Sets

Sr. No.	Description	Unit	Technical Particulars
12.23.1	**General**		
(a)	Set Manufacturer		
(b)	Type		Silent Set with AMF
(c)	Sound Level at 1 metre distance		< 75 dB
12.23.2	**Alternator**		
(a)	Manufacturer		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Type		Salient pole, Revolving field, Brushless type
(c)	Rating	KVA	(*)
(d)	Voltage	V	415
(e)	Frequency	Hz	50
(f)	Overload Capacity		10% overload for 1 hour in any 12 hours
(g)	Insulation		Class H with Class F temperature rise
(h)	Short circuit current		3 times full load current for 10 sec
(i)	Degree of protection		IP 23 with IP 54 for terminal box
(j)	Current	A	(*)
(k)	Power Factor		0.8
12.23.3	**Diesel Engine**		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(a)	Manufacturer		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Type		Four stroke, direct injection, turbocharged
(c)	Rating	KW	(*)
(c)	Speed	rpm	1500
(d)	Fuel Specification		As per manufacturer's standard
(e)	Overload Capacity		10% overload for 1 hour in any 12 hours
(f)	Class of governance		Class A2
12.23.4	Day oil tank capacity with all necessary connections for fuel flow from day tank to DG engine with level sensors, inlet, outlet piping with valves and accessories etc. Complete	Litres	990 (DG Set rating less than 200kVA fuel storage shall require to run minimum 10 hours continuously)

12.23 Variable Frequency Drives

Sr. No.	Description	Unit	Technical Particulars
12.24.1	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
12.24.2	Type of Drive		Inverter Controlled A.C Drives
12.24.3	Rated voltage, frequency and phases		415V, 50Hz, 3Phase
12.24.4	Variation in voltage		415V $\pm$ 10
12.24.5	Variation in frequency		50Hz $\pm$ 5
12.24.6	Type of Duty		100% continuous, 150 % overload for 2 minutes once in period of 24 hours, 200 % overload for 10 seconds once in period of 24 hours
12.24.7	Design Ambient Temperature		45^0C
12.24.8	Overall Harmonic Limitation (THDi)		Less than 5% (including current and voltage harmonics)
12.24.9	Application		As per Clause 12.14.4 of Part 12–Particular Electrical Plant Requirements
12.24.9.1	Interfaces		Serial / Profibus

12.24 Battery

Sr. No.	Description	Unit	Technical Particulars
12.25.1	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
12.25.2	Type of battery		Ni-Cd
12.25.3	Applicable Standards		As per Specification
12.25.4	Number of battery banks required		(*)
12.25.5	Ambient conditions		Min. Temp. 25° C
			Max. Temp 45° C
12.25.6	D.C. system voltage	V	110 ±10%
12.25.7	Ampere hour capacity of battery at 27 Deg. C at 5-hour rate to give final cell voltage of 1.16 volts/cell	Ah	As per the Requirement
12.25.8	Momentary load/duration	A	

12.25.9	Emergency load/duration	A	To be furnished by the Bidder
12.25.10	Continuous load/duration	A	
12.25.11	Nominal voltage	V	1.2 V per cell
12.25.12	Cell voltage - initial/final	V	1.42/1.14 V
12.25.13	Number of cells per bank required to give rated voltage	Nos	(*)
12.25.14	Number of spare cells per bank	Nos	(*)
12.25.15	Mounting arrangement		Multi tier
12.25.16	Charging method		Float cum boost charging

12.25 Battery Charger

Sr. No.	Description	Unit	Technical Particulars
12.26.1	**General**		
(a)	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Applicable Standards		As per Specification
(c)	Type		Float and Float cum Boost Charge
(d)	Number required	Nos	(*)
(e)	Rated Output voltage (DC)	V	110
(f)	Rated Output	kW	(*)
(g)	DC System Earthing		Unearthed
(h)	Voltage regulation from no load to rated load	%	± 1
(i)	Ambient Design Temperature	Deg C	45
(j)	**AC ripple in DC output voltage at rated continuous load**		Less than 1%
(k)	**Type of rectifier**		SCR, full wave fully controlled
(l)	**Transformer**		Copper double wound dry type with class-F insulation
(m)	Float/Trickle charging current of battery	mA	As per manufacturer
(n)	Boost Charging Current of Battery (Maximum)	A	As per manufacturer
(o)	Boost Charging Voltage of Battery (maximum)	V	As per manufacturer

Sr. No.	Description		Unit	Technical Particulars
(p)	Maximum Time for Boost charging of Battery		hr	As per manufacturer
12.26.2	**Battery Details**			
(a)	Float/Trickle charging current of battery		mA	As per manufacturer
(b)	Boost Charging Current of Battery (Maximum)		A	As per manufacturer
(c)	Boost Charging Voltage of Battery (maximum)		V	As per manufacturer
(d)	Maximum Time for Boost charging of Battery		hr	As per manufacturer
(e)	Battery capacity & no. of cells		Ah	(*)
			Nos.	(*)
12.26.3	**AC System Data**			
(a)	Supply	Voltage	V	415
		Phase		3
(b)	(i) Variation in supply Voltage		%	± 10
	(ii) Variation in supply frequency		%	± 5
(c)	Short Circuit level		kA	50
(d)	Type of earthing			Solidly Earthed
12.26.4	**Performance**			
(a)	DC voltage setting adjustment for float charger			±10% of nominal voltage
(b)	Voltage stabilisation for constant voltage regulator			±1% of set D.C. voltage, with AC input variation and DC load variation from 0 to 100%
(c)	Maximum permissible variation in DC voltage (no load to full load)			± 1%
(d)	D.C. voltage setting adjustment for boost charging			70% to 100% of max. boost charging voltage
(e)	D.C. current adjustment for boost Charging			30% to 100% of max. boost charging current
(f)	Current stabilisation for constant current regulator for boost charger			± 2%
(g)	Minimum permissible power factor to rated continuous load			0.8
(h)	Permissible ripple content at rated continuous load			3% (maximum)
(i)	Relay for auto changeover from Float to boost mode to be provided (in case			Yes

Sr. No.	Description		Unit	Technical Particulars
	of float-cum-boost charger)			
12.26.5	**Constructional Features**			
(a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partition		mm	Cold rolled 2.0
(b)	Degree of protection			IP 42
(c)	Colour finish shade			Interior: Glossy white
				Exterior: Light Grey Semi Glossy Shade 631 of IS 5
(d)	Earthing bus	Material		Copper
		Size	mm x mm	(*)
(e)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(f)	Cable entry			Bottom
(g)	Cable Sizes (i) Battery		sq.mm	(*)
	(ii) DC output		sq.mm	(*)
	(iii) AC input		sq.mm	(*)

12.26 DC Distribution Board

Sr. No.	Description	Unit	Technical Particulars
12.27.1	**General**		
(a)	Make		
(b)	Applicable standards		As per specification
(c)	Quantity	Nos	(*)
(d)	DC System voltage (Nominal)	V	110
(e)	DC System Earthing		Unearthed
(f)	Ambient Design Temperature	Deg. C	45° C
(g)	Busbar material, rating and size		Copper, Rating & Size (*)
12.27.2	**DC Bus Load**		
(a)	Total continuous DC load	A	(*)
(b)	Short time loads (Additional to continuous loads)		
	(i) DC lights/Facia lamps	A	(*)

	(ii) Starting current and duration of Largest Connected DC Motor		A	(*)
			Secs	(*)
12.27.3	**Constructional Features**			
(a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partition		mm	CRCA 2.0 min.
(b)	Degree of protection			IP 54
(c)	Colour finish shade			Interior: Glossy white
				Exterior: Light Grey Semi Glossy Shade 631 of IS 5
(d)	Earthing bus	Material		Copper (run throughout the panel)
		Size	mm x mm	(*)
(e)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(f)	Cable entry			Bottom
(g)	Cable Sizes (i) DC Input from Battery		sq.mm	(*)
	(ii) DC output to Load		sq.mm	(*)

12.27 Cables

Sr. No.	Description	Unit	Technical Particulars
12.28.1	**11kV (UE) XLPE Insulated Power Cables**		
(a)	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Applicable Standards		As per specification
(c)	Cable size selection		As per requirement
(d)	Continuous current rating with cable laid in air/ ground under specified ambient temperature	A	(*)
(e)	Conductor material		Stranded, aluminium, EC grade/class-2
(f)	Conductor screening		Semiconducting compound by extrusion
(g)	Insulation		Extruded XLPE
(h)	Screening on Insulation		Semiconducting compound by extrusion (non-metallic), copper tape (metallic)

Sr. No.	Description	Unit	Technical Particulars
(i)	Identification of codes		By providing strip of Red, Yellow & Blue colours
(j)	Inner sheath		Extruded PVC, type ST-2
(k)	Filler material		PVC
(l)	Armouring		Galvanised steel flat strip
(m)	Outer sheath		Extruded PVC, type ST-2
(n)	Overall diameter of cable		To be furnished by the Bidder
(o)	Recommended minimum bending radius	mm	To be furnished by the bidder
(p)	Standard length of cable on each drum	mts	(*)
12.28.2	**1100V Grade XLPE Insulated Power Cables**		
(a)	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Applicable Standards		As per specification requirement
(c)	Cable size selection		As per specification
(d)	Conductor material		Stranded, aluminium/copper, EC grade
(e)	Insulation		XLPE
(f)	Inner sheath		Extruded PVC, type ST-2
(g)	Armouring		Galvanised steel flat strip/round wire
(h)	Outer sheath		Extruded PVC, type ST-2
(i)	Overall diameter of cable		To be furnished by the Bidder
(j)	Recommended minimum bending radius	mm	To be furnished by the bidder
(k)	Standard length of cable on each drum	mts	(*)
12.28.3	**650/1100V Grade PVC Insulated Control Cables**		
(a)	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement
(b)	Applicable Standards		As per specification
(c)	Rated voltage	V	As per requirement
(d)	Cable size selection		As per specifications requirement
(e)	Conductor material		Stranded, copper, EC grade
(f)	Insulation		PVC
(g)	Inner sheath		Extruded PVC, type ST-1
(h)	Armouring		Galvanised steel round wire
(i)	Outer sheath		Extruded PVC, type ST-1

Sr. No.	Description	Unit	Technical Particulars
(j)	Standard length of cable on each drum	mts	(*)

12.28 Lighting Fixtures and Accessories

Sr. No.	Description	Unit	Technical Particulars
12.29.1	**General**		
(a)	Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
(b)	Type		As per specification
(c)	Illumination levels at various premises		As per Building Services, Clause 12.16 of Part 12- Particular electrical requirements
(d)	Normal supply voltage, phase and frequency	AC	240V, 1Ph, 2 wire, 50Hz
		DC	110V, 2 wire, unearthed
(e)	Variation in supply:		
	(i) Voltage (AC & DC)	%	$\pm$ 10
	(ii) Frequency	%	$\pm$ 5
	(iii) Combined voltage & frequency	%	$\pm$ 10
(f)	Design ambient air temperature	^{0}C	45° C
12.29.2	Luminaire terminal suitable for		
(a)	Indoor area		
	(i) Conductor material		Copper
	(ii) Cable size	Coresxmm^2	(*)
(b)	Outdoor area		
	(i) Conductor material		Copper
	(ii) Cable size	Cores xmm^2	(*)
12.29.3	Luminary earthing terminal suitable for		
	(i) Conductor material		G. S. wire
	(ii) Conductor size	SWG	(*)

12.29 Lighting System and Equipment

Sr. No.	Description	Unit	Technical Particulars
12.30.1	**System Particular**		
(a)	**Voltage**		
	(i) 3 Phase, 4 wire 50 Hz system		
	• Rated	V	415
	• Maximum	V	476
	• One minute withstand voltage		3000 V AC.
	(ii) D.C. system		
	• Rated	V	110
(b)	System short-circuit level		
	(i) At 415 V, A.C.	kA (rms)	10
	(ii) At 110 V.D.C.	kA (D.C.)	6
(c)	Reference ambient temperature	^{0} C	45^0 C
12.30.2	**Distribution Board/Panels**		
(a)	Main, floor mounted distribution boards		
(i)	Main Lighting distribution board (A.C.)		
	• Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
	• Type		Floor standing, sheet steel Enclosed
	• Degree of protection		IP 54
	• Busbar material		Copper
	• Busbar current rating	A	(*)
	• Short circuit current rating	kA	(*)
	• Cable entry		Based on Layout Top or bottom
	• Location		Indoor
(ii)	Emergency lighting panel (D.C.)		

Sr. No.	Description	Unit	Technical Particulars
	• Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
	• Type		Wall mounting, sheet steel Enclosed
	• Degree of protection		IP 54
	• Busbar material		Copper
	• Busbar current rating	A	(*)
	• Short circuit current rating	kA	(*)
	• Cable entry		Based on Layout Top or bottom
	• Location		Indoor
(iii)	Single phase DBs, wall/structure mounting		
	SLDB for indoor area		
	• Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
	• Type		Wall mounting, sheet steel enclosed
	• Degree of Protection		IP 54
(iv)	SLDB for outdoor area		
	• Make		As per Preferred Makes/ Manufacturers of Part-6, General requirement.
	• Type		Wall mounting, sheet steel enclosed
	• Degree of Protection		IP 65
(v)	Paint Finish		
	(i) Colour shade:		Interior: Glossy white
			Exterior: Light gray semi glossy shade 631 of IS:5
12.30.3 (a)	**Street Light Poles and Flood Light Poles** Street Light Pole single arm		

Sr. No.	Description	Unit	Technical Particulars
	Total Height:	m	7.5
	Quantity:	Nos.	(*)
(b)	Floodlight Light Pole		
	Total height:	mts.	9
	No. Of floodlights to be fixed per pole	No.	(*)

12.30 Lighting system Installation work

Sr. No.	Description	Unit	Technical Particulars
1 (a)	**Installation of Earthing Conductor** Indoor Areas		
	(i) Size	SWG	12 (*)
	(ii) Material		G.S. wire
(b)	Outdoor Areas		
	(i) Size	SWG	8 (*)
	(ii) Material		G.S. wire
2 (a)	**Installation of Conduits** Rigid		
	(i) Material		Galvanised steel
	(ii) Sizes	mm^2	20 (*)
3 (a)	**Installation of Wires/Cables** 1100 V, 1 Core, PVC Insulated Wires		
	(i) Conductor material		Copper
	(ii) Size	sq.mm	Lighting 1Cx1.5(*) Receptacles 1Cx2.5(*)
	(iii) Colour Coded 'Black'	Metres	
	(iv) Colour Coded 'White'	Metres	
(b)	1100 V, PVC Insulated PVC Sheathed Armoured Cable		
(c)	Size & cores	Core x mm^2	g) 2C X 4 and 2C X 6
			ii) 4C X 6
4	Contractor shall route and supply these items as required.		
5	Supply of earthing conductors, mounting accessories and all fixing hardware are included as part of the installation work.		
6	Supply of conduits and wires/cables and all fixing hardware are included as a part of installation work.		

12.32 Earthing and Lightning Protection System

Sr. No.	Description	Technical Particulars		
		Size	**Material**	**No. of Leads & Quantity**
12.31.1 (a)	**Main Earthing Grid** Buried in earth	(*)	MS	Quantity as per requirement
(b)	Buried in floor slabs in buildings	(*)	MS	Quantity as per requirement
12.31.2	**Conductor Leads to Equipment** (above ground)			Number of Leads As per relevant Standards, Quantity as per requirements
(a)	Transformers			
(i)	Transformer neutral to bottom of tank	(*)	copper	
(ii)	From bottom of tank to earth grid	(*)	GS	
(iii)	Transformer tanks and radiator bank	(*)	(GS	
(b)	Diesel Generator Set			
(i)	DG Set neutral earthing	(*)	GS	
(ii)	DG Set body earthing	(*)	GS	
(c)	Fence posts and gates (Flex. braid)	(*)	GS	
12.31.3	11kVMetal Enclosed Switchboard, 415Vswitchgear/ MCC.	(*)	GS	
12.31.4	Motors			
(a)	415V Motors above 10 kW	(*)	GS	
(b)	415V Motors up to 10 kW	(*)	GS	
(c)	Fractional horse power motors	(*)	GS	
12.31.5	**Other Items**			
(a)	Capacitor panel, Battery charger panel, DC distribution board, Main lighting D.B, Control panels and sub-lighting distribution boards	(*)	GS	
(b)	Hand Rails	(*)	GS	
(c)	Cable trays	(*)	GS	
(d)	Tanks	(*)	GS	
(e)	Junction boxes	(*)	GS wire	
(f)	Lighting fixtures, receptacles, lighting conduits	(*)	GS wire	
(g)	Push button stations, limit switches	(*)	GS wire	
12.31.6	**Crane rail**	(*)	GS	
12.31.7	Street lighting, flood lighting	(*)	GS	

Sr. No.	Description	Technical Particulars		
	poles and junctions' boxes			
12.31.8	Metallic non-current carrying structures	(*)	GS	
12.31.9	**Lightning Conductors**			
(a)	Lightning protection down comers for building	(*)	GS	
(b)	Lightning protection horizontal roof conductor for building	(*)	GS	
9.31.10	**Electrodes**	(*)	Heavy duty 40mm diameter GI pipe 3000 mm long	Quantity as per requirements
(a)	Pipe electrode	(*)		

Note: Any requirement / features / provisions not specifically mentioned in the Specification but are necessary for trouble free and smooth operation of the Plant System shall be included.

(i) (*) – The numbers, ratings, sizes etc shall be worked out by the contractor during execution and to be approved by the Engineer.

(ii) Contractor shall notify the Employer for factory inspection and testing of equipment as defined in Clause 14.1.2, Materials, Plant & Equipment of Part 14, Volume -2 of the Bid document.

12.31 Control and Relay Panel

Sr. No.	Description		Technical Particulars
(a)	Control / Relay panel designation		
(b)	Type : Simplex / Duplex /Mosaic/Panel cum Desk		Simplex
(c)	Cold rolled sheet steel thickness		Frame – 3 mm thick
(d)	(i) Front and rear (ii) Sides, top and bottom		3 mm (min.) 2 mm for sides, 3 mm thick Gland plates
(e)	Painting (i) Finish Enamel/Epoxy (ii) Colour Shade to IS 5.		RAL 7032
(f)	Cable Entry - Top / Bottom		Bottom
(g)	Mimic Bus colour (If required) for different voltages.		Screw on type painted aluminum strip of 12 mm x 3 mm thick
(h)	Earth bus material and size, inside the panel.		25 mm x 3 mm tinned Copper (minimum)
(i)	Degree of protection		IP 54
(j)	Auxiliary voltages to panels a) AC DC		240 V AC 1 phase 110 V DC (dual feed)

Note:

(i) Any requirement/ features/ provisions not specifically mentioned in the Specification, but are necessary for trouble free and smooth operation of the Plant System shall be included.

(ii) (*) – The numbers, ratings, sizes etc. have to be worked out by the contractor during execution and to be approved by the Engineer.

End of Part 12